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ANTHRIBUS NEBULOSUS, A EURASIAN SCALE PREDATOR IN THE EASTERN UNITED STATES (COLEOPTERA: ANTHRIBIDAE): NOTES ON BIOLOGY, RECOGNITION, AND ESTABLISHMENT

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Abstract.—The Eurasian *Anthribus nebulosus* Forster is a scale predator that was introduced from Europe and released in Virginia in the late 1970s for potential control of pest species. New records of this natural enemy of soft scales are given for Connecticut, Massachusetts, and New York, where it was collected on spruce (*Picea* spp.) infested with the bud scale *Physokermes hemicryphus* (Dalman). It is suggested that this anthribid is adventive in the northeastern states and that populations were established before its intentional introduction into Virginia. The Old World distribution and habits are summarized, and characters facilitating its recognition in the Nearctic fauna are provided.

Key Words: Insecta, biological control, Coccoidea, *Physokermes,* immigrant insects

During detection surveys for immigrant arthropods conducted in the northeastern United States, we discovered *Anthribus nebulosus* Forster, a Eurasian scale predator. On 29 May 1989, numerous adults were beaten from the lower branches of a Colorado blue spruce (*Picea pungens* Engelm.) growing adjacent to the Wesleyan University campus, Middletown, Connecticut. The tree was infested with the introduced bud scale *Physokermes hemicryphus* (Dalman). Although long identified as the European *P. piceae* Schrank, the Old World bud scale introduced into North America has been shown to be *P. hemicryphus* (Williams and Kosztarab 1972, Gill 1988). Additional anthribids were found in mid-July from western Connecticut and Massachusetts to eastern New York.

We consider *A. nebulosus* to be adventive in the northeastern United States, even though this predator had been intentionally introduced from Europe into Virginia (Kosztarab and Kozar 1983). Adults were collected in Hungary in 1975 and 1977, reared and evaluated for their biocontrol potential against various scale insects, and released on the Virginia Tech campus at Blacksburg in fall 1978 and 1979. These beetles were placed on Norway spruce (*P. abies* (L.) Karst.) infested with *P. hemicryphus.* Monitoring of these trees indicated establishment of *A. nebulosus* by 1979, and a scale predation rate of about 30% by August 1981. Surveys in the surrounding area revealed a small anthribid population on Norway spruce about 1 km east of the release site during fall 1981 and spring 1982; in fall 1982, a few adults were collected on Norway spruce at Radford, about 13 km southwest of Blacksburg. Field releases of the predator (300 adults) at Virginia Beach in fall 1981 apparently did not result in establishment (Kosztarab and Kozar 1983).

Here, we review the Old World distribution of *A. nebulosus,* and provide new

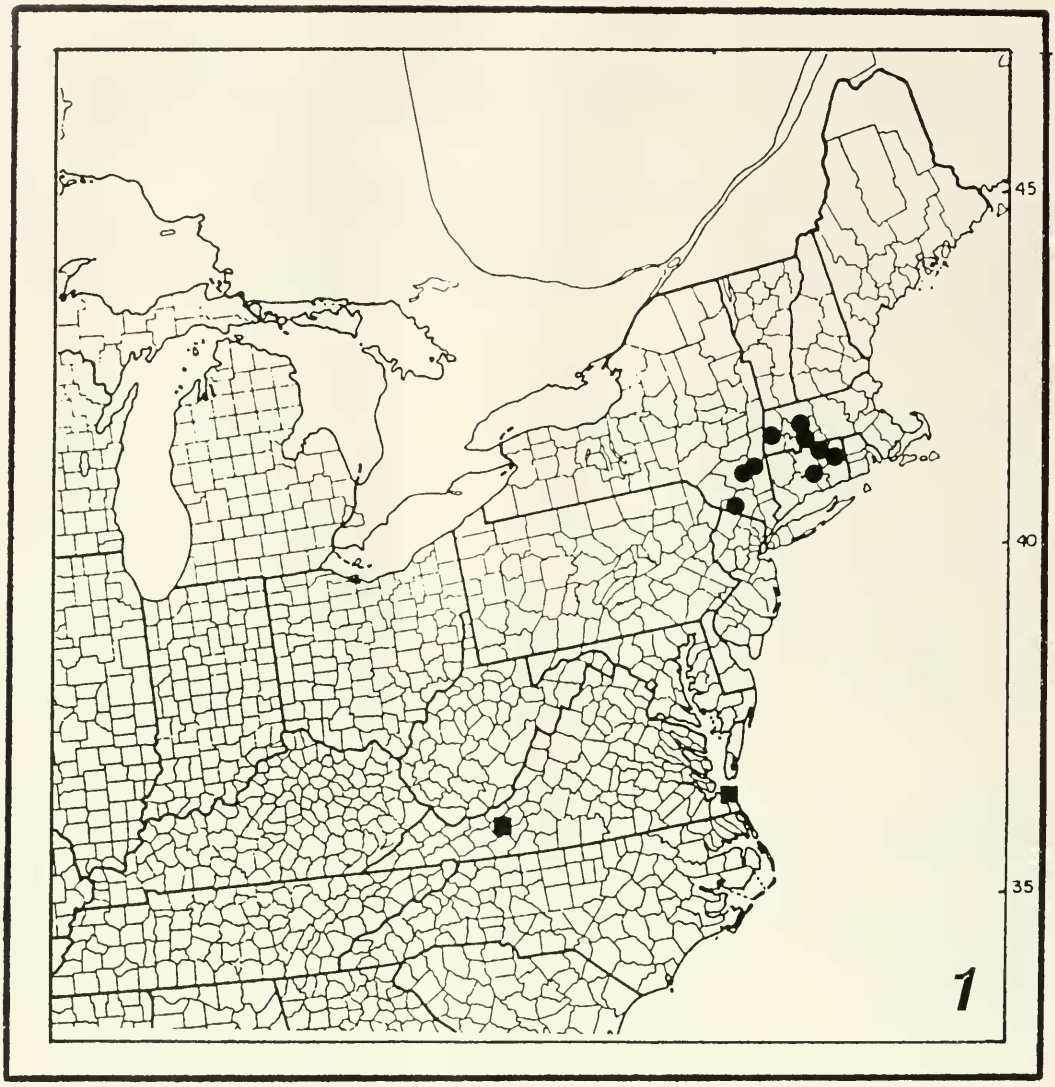
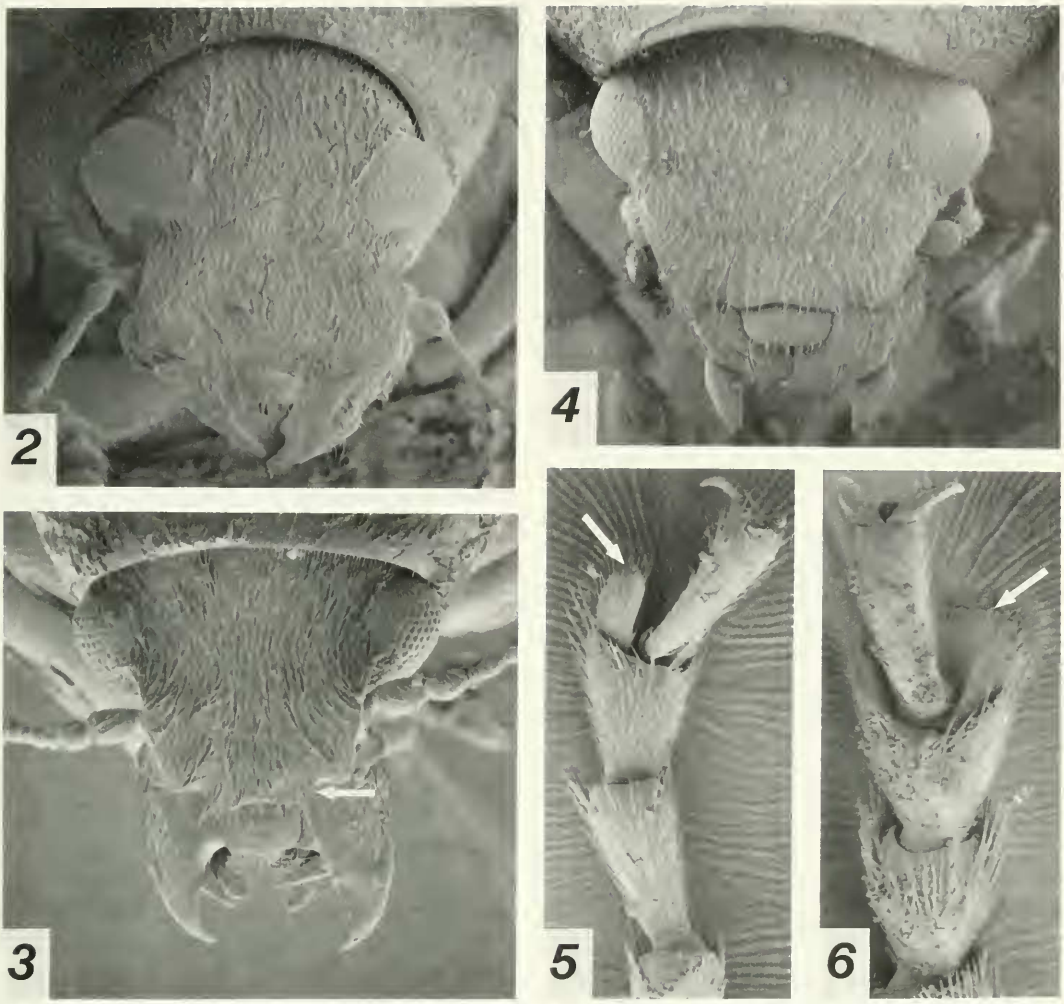


Fig. 1. Known distribution of *Anthribus nebulosus* in eastern North America. ●, denotes collection localities in 1989. ■, denotes known release sites in Virginia.

North American records. Scanning electron photomicrographs are included for salient morphological characters of *A. nebulosus* and *Trigonorhinus* spp., indigenous anthribids that could be mistaken for *A. nebulosus*. We also speculate on the origin of northeastern populations of this Old World beetle.

Distribution.—*Anthribus nebulosus* has been reported from the following Palearctic countries: Bulgaria, Finland, France, Germany, Hungary, Poland, and the USSR (Ukraine to eastern Kazakhstan). It occurs commonly in areas of deciduous forests, spruce forests, orchards, and on ornamental trees infested with prey scale insects. In the United States it has been known only from Virginia (Fig. 1), where adults originating



Figs. 2–6. Rostra and tarsal segments of Anthribidae. 2, Dorsal aspect of rostrum of *Ormiscus walshi* (LeConte). 3, Rostral apex of *Trigonorhinus sticticus* (Boheman); arrow denotes central prolongation. 4, Rostral apex of *Anthribus nebulosus* Forster. 5, Metatarsus of *T. sticticus*; arrow denotes separate lobes of third tarsomere. 6, Metatarsus of *A. nebulosus*; arrow denotes connate or fused lobes of third tarsomere.

from material collected in Europe were released to help control various species of soft scales (Coccidae).

As a result of our recent collecting, the following locality records are new for *A. nebulosus* (Fig. 1): UNITED STATES: CONNECTICUT: Middlesex Co., Middletown, Wesleyan Univ., 28-V-1989, 6-VI-1989, 15-VII-1989, and 1-X-89, ex *Picea pungens*; Middletown, Indian Head Cemetery, 15-VII-1989, ex *P. abies*; East Hampton, 15-VII-1989, ex *P. abies*; Tolland Co., Hebron, 15-VII-1989, ex *P. abies*; Somers, 15-VII-1989, ex *P. abies*; Storrs, Univ. Connecticut, 15-VII-1989, ex *P. abies*; Windham Co., Willimantic, 15-VII-1989, ex *P. abies*.

MASSACHUSETTS: Berkshire Co., nr. Stockbridge, 16-VII-1989, ex *P. abies*; Hampden Co., East Longmeadow, 15-VII-

1989, ex *P. pungens*; Hampshire Co., Amherst, Amherst College, 16-VII-1989, ex *P. abies*; Amherst, Univ. Massachusetts, 16-VII-1989, ex *P. glauca*; Northampton, Smith College, 16-VII-1989, ex *P. abies*.

NEW YORK: Dutchess Co., Annandale-on-Hudson, Bard College, 16-VII-1989, ex *P. abies*; Fishkill, Fishkill Rural Cemetery, 16-VII-1989, ex *P. abies*; Red Hook, 16-VII-1989, ex *P. abies*; Orange Co., Warwick, 22-VII-1989, ex *P. abies*; Ulster Co., Kingston, St. Mary's Cemetery, 22-VII-1989, ex *P. abies*.

Voucher specimens (C.U. Lot #1193) are deposited in the collections of Cornell University (Ithaca, NY) and Pennsylvania Department of Agriculture (Harrisburg, PA).

Recognition features.—Among the anthribid taxa that occur in the eastern United States, the immigrant *Anthribus nebulosus* would most likely be confused with species of the genus *Trigonorhinus*. Several morphological and biological features characteristic for each genus were described by Valentine (1960). Species of *Trigonorhinus* can be readily recognized by the dorsal rostral surface being progressively narrowed from base to apex (Fig. 3), with the central apical portion distinctly produced beyond the corners and slightly emarginate (Fig. 3). The lobes of the third tarsal segment are separate, giving the appearance of a deeply lobed third segment (Fig. 5). In contrast, species of *Anthribus* lack the apical prolongation of the rostrum (Fig. 4), and the lobes of the third tarsal segment are connate or fused (Fig. 6).

Trigonorhinus species are strictly plant feeders, as the majority of the Anthribidae, whereas species of *Anthribus* (formerly *Brachytarsus* Schoenherr) have larvae that are predacious on eggs of certain lecaniine scale insects (Valentine 1960).

Anthribus nebulosus keys nearest to *Trigonorhinus* in Valentine (1960) because of the narrowed rostrum. Couplet 19 of that work is modified as follows to accommodate this established immigrant.

19. Rostrum, excluding mandibles, quadrate, or slightly widened from base to apex (Fig. 2) 20
Rostrum, excluding mandibles, narrowed from base to apex (Figs. 3–4) 19a

19a. Rostral apex distinctly produced at middle, with central prolongation slightly emarginate (Fig. 3); lobes of third tarsomere separate (Fig. 5) ..... *Trigonorhinus* Wollaston (21 North American species, *sensu* Valentine 1960)
Rostral apex truncate, lacking central prolongation (Fig. 4); lobes of third tarsomere connate or fused (Fig. 6) .... *Anthribus* Forster (1 North American species, *A. nebulosus* Forster)

Biology and seasonal history.—Kosztarab and Kozar (1983) thoroughly summarized the literature that documents *Anthribus nebulosus* as an effective predator of at least 15 species of scale insects in Europe and Central Asia. Three of these scales are also considered pest species in the eastern United States, i.e. the European fruit lecanium, *Parthenolecanium corni* (Bouche); a nut scale, *Eulecanium tiliae* (L.); and a spruce bud scale, *Physokermes hemicryphus*. They noted the potential for *A. nebulosus* to suppress populations of other pest scale insects in North America because it feeds on closely related scales in Europe.

For additional references to aspects of biology and seasonal history of *A. nebulosus* in Europe and in Virginia, the reader is referred to Kosztarab and Kozar (1983) and Kosztarab and Rhoades (1983).

Discussion.—In New England, the Eurasian predator *A. nebulosus* is common on Norway spruce; we also collected it on Colorado spruce and on white spruce (*Picea glauca* (Moench.) Voss). Available evidence suggests that populations of *A. nebulosus* in the northeastern states are adventive rather than associated with releases made in Virginia. In many of the areas surveyed in southern New England, 20 or more adults could be quickly collected from a scale-infested spruce. Beetles were more difficult to obtain in eastern New York. The presence of large numbers in parts of Connecticut and

Massachusetts seem to point to long-standing populations rather than recent population outbreaks.

The principal prey of this adventive predator is the introduced *Physokermes hemicryphus,* a soft scale first collected in North America near Hartford, Connecticut, in 1906. Other early records of this scale are from Massachusetts, New Hampshire, New York, Pennsylvania, Ontario, and Wisconsin (Fenton 1917). Thus a suitable food source has existed in New England throughout the twentieth century.

Although clearly speculative, we suggest the anthribid could have been introduced into the eastern states as early as the late nineteenth or early twentieth century. Before passage of the Plant Quarantine Act of 1912, millions of seedlings and larger plants entered the United States each year (e.g. Symons 1911), including insect-infested spruce trees (Marlatt 1912).

The low dispersion rate reported for *A. nebulosus* in Virginia (Kosztarab and Kozar 1983) is evidence that the widespread New England populations are of long-standing origin. Even if some of the adults released in fall 1978 and 1979 had dispersed widely, it seems unlikely that the beetle could have become so abundant and widespread in New England within ten years. A mass appearance of *A. nebulosus* in New England due to passing weather conditions also cannot be dismissed, but any origin of northeastern populations based on long-range movement from Virginia seems implausible.

Our surveys for the anthribid in New York just west of the Hudson River, and in parts of Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia, were negative. These surveys were made on scale-infested spruces during the period of known adult activity, as reported by Kosztarab and Kozar (1983). This suggests that *A. nebulosus* may not be established in these areas, or at least is not as widespread and abundant as in southern New England.

Anthribus nebulosus apparently represents another example of a natural enemy that was accidentally introduced and that became established before it was considered for intentional introduction and release by biological control workers. Mason (1978) provided examples of Old World ichneumonid parasitoids already established in North America before their intentional introduction for biocontrol of insect pests. Some similar cases are found in Clausen's (1978) world review of introduced natural enemies. Goeden (1983) gave several examples of the fortuitous introductions of insects later released for biocontrol of weeds. Goeden (1983) and Schroeder and Goeden (1986) advocated prerelease inventories of weeds targeted for biocontrol to minimize such "surprise" detections of adventive species. But *A. nebulosus* was not among the known enemies of Virginia coccids (Williams and Kosztarab 1972:209–210), and Kosztarab and Kozar (1983) thus had no reason to suspect that the anthribid occurred anywhere in North America before it was collected in Hungary and released in Virginia.

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